

AMENDMENTS TO THE CLAIMS

This listing of claims will replace all prior versions and listings of claims in the application:

LISTING OF CLAIMS:

1. (currently amended): A method of controlling an ink jet recording apparatus on which a liquid container is able to be detachably mounted, said liquid container having a container body containing a liquid supplied to a recording head discharging an ink droplet from a nozzle opening and a piezoelectric device for detecting said liquid within said container body, comprising the steps of:

detecting a characteristic value of said piezoelectric device by a detection section provided inside or outside of said ink jet recording apparatus;

judging whether or not said characteristic value satisfies a predetermined condition by a judging section provided inside or outside of said ink jet recording apparatus; and

controlling said ink jet recording apparatus so that said ink jet recording apparatus is set in an operable state or in a non-operable state based on a result of said judging step,

wherein said piezoelectric device has a vibrating portion which comes into contact with said liquid in said container body via a cavity, said cavity defining an area of said vibrating portion,

wherein said characteristic value is detected based on a signal output from said piezoelectric device, said signal indicating a residual oscillating state of said vibrating portion of

said piezoelectric device, said characteristic value changing based on phenomenon that said residual oscillating state changes corresponding to a liquid consuming state.

2. (currently amended): A method of controlling an ink jet recording apparatus ~~according to claim 1~~, on which a liquid container is able to be detachably mounted said liquid container having a container body containing a liquid supplied to a recording head discharging an ink droplet from a nozzle opening and a piezoelectric device for detecting said liquid within said container body, comprising the steps of:

detecting a characteristic value of said piezoelectric device by a detection section provided inside or outside of said ink jet recording apparatus;

judging whether or not said characteristic value satisfies a predetermined condition by a judging section provided inside or outside of said ink jet recording apparatus; and

controlling said ink jet recording apparatus so that said ink jet recording apparatus is set in an operable state or in a non-operable state based on a result of said judging step,

wherein said detecting step is executed at the time that said liquid container is mounted on said ink jet recording apparatus.

3. (original) A method of controlling an ink jet recording apparatus according to claim 1, further comprising a step of measuring a consumption volume of said liquid within said liquid container until at least a predetermined volume by a measuring section provided inside or outside of said ink jet recording apparatus.

4. (original) A method of controlling an ink jet recording apparatus according to claim 1, further comprising a step of, in a case that said ink jet recording apparatus is in said non-operable state, selecting either to maintain said non-operable state of said ink jet recording apparatus or to change said non-operable state of said ink jet recording apparatus to said operable state.

5. (original) A method of controlling an ink jet recording apparatus according to claim 1, wherein said characteristic value is an element characteristic value of a piezoelectric element of said piezoelectric device.

6. (original) A method of controlling an ink jet recording apparatus according to claim 1, wherein said characteristic value is an oscillation characteristic value of an oscillating portion of said piezoelectric device.

7. (original) A method of controlling an ink jet recording apparatus according to claim 1, wherein said liquid container is provided with at least two said piezoelectric devices,
wherein said detection section detects oscillation characteristic values of said at least two piezoelectric devices in said detecting step, and

wherein said judging section judges a consumption state of said liquid within said liquid container based on a relative condition of mutual oscillation characteristic values of said at least two piezoelectric devices in said judging step.

8. (currently amended): An apparatus for controlling an ink jet recording apparatus on which a liquid container is able to be detachably mounted, said liquid container having a container body containing a liquid supplied to a recording head discharging an ink droplet from a nozzle opening and a piezoelectric device for detecting said liquid within said container body, comprising:

a detection section for detecting a characteristic value of said piezoelectric device, said detection section being provided inside or outside of said ink jet recording apparatus;

a judging section for judging whether or not said characteristic value satisfies a predetermined condition, said judging section being provided inside or outside of said ink jet recording apparatus; and

a controlling section for controlling said ink jet recording apparatus so that said ink jet recording apparatus is set in an operable state or in a non-operable state based on a result obtained by said judging section;

wherein said piezoelectric device has a vibrating portion which comes into contact with said liquid in said container body via a cavity, said cavity defining an area of said vibrating portion.

wherein said characteristic value is detected based on a signal output from said piezoelectric device, said signal indicating a residual oscillating state of said vibrating portion of said piezoelectric device, said characteristic value changing based on phenomenon that said residual oscillating state changes corresponding to a liquid consuming state.

9. (original) An apparatus for controlling an ink jet recording apparatus according to claim 8, wherein said detection section detects oscillation characteristic values of at least two said piezoelectric devices which are attached to said liquid container, and

wherein said judging section judges a consumption state of said liquid within said liquid container based on a relative condition of mutual oscillation characteristic values of said at least two piezoelectric devices.

10. (currently amended): A liquid container comprising:
a container body containing a liquid;
a liquid supplying opening for supplying said liquid outside of said container body; and
a piezoelectric device for detecting said liquid within said container body, said piezoelectric device being positioned nearby a liquid level of said liquid when said liquid is not consumed,

wherein said piezoelectric device has a vibrating portion which comes into contact with said liquid in said container body via a cavity, said cavity defining an area of said vibrating portion.

wherein a characteristic value is detected based on a signal output from said piezoelectric device, said signal indicating a residual oscillating state of said vibrating portion of said piezoelectric device, said characteristic value changing based on phenomenon that said residual oscillating state changes corresponding to a liquid consuming state.

11. (original) A liquid container according to claim 10, further comprising an additional piezoelectric device for detecting said liquid within said container body.

12. (original) A liquid container according to claim 11, wherein said additional piezoelectric device is positioned nearby a bottom surface of said container body.

13. (original) A liquid container according to claim 11, wherein said additional piezoelectric device is positioned nearby said piezoelectric device, an initial liquid level when said liquid within said container body is not consumed being located between said piezoelectric device and said additional piezoelectric device.

14. (original) A liquid container according to claim 10, wherein said piezoelectric device and said additional piezoelectric device have oscillating sections contacting with a medium within said container body, respectively, and

wherein oscillation characteristic values of said oscillating sections are detected.

15. (original) A liquid container according to claim 10, wherein said liquid container is adapted to be mounted on an ink jet recording apparatus which performs a recording by a recording head discharging an ink droplet, said liquid within said container body being supplied to said recording head.

16. (currently amended): An ink jet recording apparatus on which a liquid container is able to be detachably mounted, said liquid container having a container body containing a liquid and a piezoelectric device for detecting said liquid within said container body, comprising:

a recording head receiving said liquid from said liquid container and discharging an ink droplet from a nozzle opening; and

a controller for controlling an operation state of said ink jet recording apparatus, said controller including:

a detection section for detecting a characteristic value of said piezoelectric device, said detection section being provided inside or outside of said ink jet recording apparatus;

a judging section for judging whether or not said characteristic value satisfies a predetermined condition, said judging section being provided inside or outside of said ink jet recording apparatus; and

a controlling section for controlling said ink jet recording apparatus so that said ink jet recording apparatus is set in an operable state or in a non-operable state based on a result obtained by said judging section.

wherein said piezoelectric device has a vibrating portion which comes into contact with said liquid in said container body via a cavity, said cavity defining an area of said vibrating portion,

wherein said characteristic value is detected based on a signal output from said piezoelectric device, said signal indicating a residual oscillating state of said vibrating portion of said piezoelectric device, said characteristic value changing based on phenomenon that said residual oscillating state changes corresponding to a liquid consuming state.

17. (original) An ink jet recording apparatus according to claim 16, further comprising a storage device capable of storing at least said characteristic value.

18. (original) An ink jet recording apparatus according to claim 16, further comprising a measuring section for measuring a liquid consuming volume within said liquid container until at least a predetermined volume.

19. (original) An ink jet recording apparatus according to claim 16, wherein said detection section detects oscillation characteristic values of at least two said piezoelectric devices which are attached to said liquid container, and

wherein said judging section judges a consumption state of said liquid within said liquid container based on a relative condition of mutual oscillation characteristic values of said at least two piezoelectric devices.

20. (original) A method of detecting a liquid consumption state of a liquid container mounted on an ink jet recording apparatus, said liquid container having a container body containing a liquid supplied to a recording head discharging an ink droplet from a nozzle opening and a piezoelectric device for detecting said liquid within said container body, comprising the steps of:

detecting oscillation characteristic values of at least two said piezoelectric devices attached to said liquid container by a detection section, said detection section being provided inside or outside of said ink jet recording apparatus; and

judging a consumption state of said liquid within said liquid container based on a relative condition of mutual oscillation characteristic values of said at least two piezoelectric devices by a judging section, said judging section being provided inside or outside of said ink jet recording apparatus.

21. (original) A method of detecting a liquid consumption state according to claim 20, wherein said relative condition of said oscillation characteristic values is that said oscillation characteristic values of said at least two piezoelectric devices are approximately equal to each other.

22. (original) An ink jet recording apparatus on which a liquid container is able to be detachably mounted, said liquid container having a container body containing a liquid and a piezoelectric device for detecting said liquid within said container body, comprising:

a recording head receiving said liquid from said liquid container and discharging an ink droplet from a nozzle opening; and

a controller for controlling an operation state of said ink jet recording apparatus, said controller including:

a detection section for detecting oscillation characteristic values of at least two said piezoelectric devices attached to said liquid container; and

a judging section for judging a consumption state of said liquid within said liquid container based on a relative condition of mutual oscillation characteristic values of said at least two piezoelectric devices.

23. (original) An ink jet recording apparatus according to claim 22, wherein said relative condition of said oscillation characteristic values is that said oscillation characteristic values of said at least two piezoelectric devices are approximately equal to each other.

24. (previously presented) The apparatus for controlling an ink jet recording apparatus according to claim 8, wherein an oscillating section of said piezoelectric device is positioned just below an initial liquid level of said liquid.

25. (currently amended) ~~The apparatus for controlling an ink jet recording apparatus according to claim 8,~~ An apparatus for controlling an ink jet recording apparatus on which a liquid container is able to be detachably mounted, said liquid container having a container body containing a liquid supplied to a recording head discharging an ink droplet from a nozzle opening and a piezoelectric device for detecting said liquid within said container body, comprising:

a detection section for detecting a characteristic value of said piezoelectric device, said detection section being provided inside or outside of said ink jet recording apparatus;

a judging section for judging whether or not said characteristic value satisfies a predetermined condition, said judging section being provided inside or outside of said ink jet recording apparatus; and

a controlling section for controlling said ink jet recording apparatus so that said ink jet recording apparatus is set in an operable state or in a non-operable state based on a result obtained by said judging section,

wherein a vibrating region of said piezoelectric device extends from an initial liquid level of said liquid, before said liquid is consumed, to a bottom surface of said liquid container.

26. (new) An ink cartridge configured to be detachably mounted on an ink jet recording apparatus comprising:

a container body containing an ink;

an ink supplying opening for supplying said ink to said ink jet recording apparatus; and

a piezoelectric device for detecting said ink within said container body, said piezoelectric device being positioned slightly below an initial ink level which corresponds to a level of said ink in said container body before bringing said ink cartridge into use.

27. (new) An ink cartridge according to claim 26, wherein said piezoelectric device has a vibrating portion which comes into contact with said ink in said container body via an opening, said opening defining an area of said vibrating portion.

28. (new) The method of controlling an ink jet recording apparatus according to claim 1, wherein said vibrating portion comes into contact with said liquid via a cavity in said container body or said piezoelectric device, said vibrating portion covering an area of an outer opening of said cavity.

29. (new) The apparatus for controlling an ink jet recording apparatus according to claim 8, wherein said vibrating portion comes into contact with said liquid via a cavity in said container body or said piezoelectric device, said vibrating portion covering an area of an outer opening of said cavity.

30. (new) The ink jet recording apparatus according to claim 16, wherein said vibrating portion comes into contact with said liquid via a cavity in said container body or said piezoelectric device, said vibrating portion covering an area of an outer opening of said cavity.

31. (new): A method of controlling an ink jet recording apparatus on which a liquid container is able to be detachably mounted, comprising:

detecting a characteristic value of a piezoelectric device of the liquid container;

determining whether or not the characteristic value satisfies a predetermined condition;

and

setting the ink jet recording apparatus in a first state or in a second state based on whether or not the characteristic value satisfies the predetermined condition,

wherein the piezoelectric device comprises a vibrating portion that contacts liquid in the liquid container via a cavity of the liquid container, and

wherein the vibrating portion covers an outer opening of the cavity.

32 (new): The method as claimed in claim 31, wherein the first state is an operable state of the ink jet recording apparatus, and

wherein the second state is a non-operable state of the of the ink jet recording apparatus.

33. (new): A method of controlling an ink jet recording apparatus, on which a liquid container is able to be detachably mounted, comprising:

detecting a characteristic value of a piezoelectric device of the liquid container;

determining whether or not the characteristic value satisfies a predetermined condition;

and

setting the ink jet recording apparatus in first state or in a second state based on based on whether or not the characteristic value satisfies the predetermined condition,

wherein the characteristic value is detected when the liquid container is being mounted on the ink jet recording apparatus.

34 (new): The method as claimed in claim 33, wherein the first state is an operable state of the ink jet recording apparatus, and

wherein the second state is a non-operable state of the of the ink jet recording apparatus.

35. (new): An apparatus for controlling an ink jet recording apparatus on which a liquid container is able to be detachably mounted, comprising:

a detection circuit that detects a characteristic value of a piezoelectric device of the liquid container; and

a control circuit that determines whether or not the characteristic value satisfies a predetermined condition and that sets the ink jet recording apparatus in a first state or in a second state based on whether or not the characteristic value satisfies the predetermined condition,

wherein the piezoelectric device has a vibrating portion that contacts liquid in the liquid container via a cavity of the liquid container, and

wherein the vibrating portion covers an outer opening of the cavity.

36 (new): The method as claimed in claim 35, wherein the first state is an operable state of the ink jet recording apparatus, and

wherein the second state is a non-operable state of the of the ink jet recording apparatus.

37. (new): A liquid container comprising:

a container that contains liquid; and

a piezoelectric device that is coupled to the container and that is positioned near a level of the liquid when the liquid has not been consumed,

wherein the piezoelectric device has a vibrating portion that contacts the liquid via a cavity of the container, and

wherein a characteristic value is detected based on a signal output from said piezoelectric device, said signal indicating a residual oscillating state of a vibrating portion of said piezoelectric device, said characteristic value changing based on phenomenon that said residual oscillating state changes corresponding to a liquid consuming state.

38. (new): An ink jet recording apparatus on which a liquid container is able to be detachably mounted, comprising:

a recording head that receives the liquid from the liquid container and discharges a droplet of the liquid from a nozzle opening; and

a controller that detects a characteristic value of the piezoelectric device, that determines whether or not the characteristic value satisfies a predetermined condition, that sets the ink jet

recording apparatus in a first state or in second state based on whether or not the characteristic value satisfies the predetermined condition,

wherein the piezoelectric device has a vibrating portion that contacts the liquid via a cavity in the liquid container, and

wherein the vibrating portion covers an outer opening of the cavity.

39 (new): The method as claimed in claim 38, wherein the first state is an operable state of the ink jet recording apparatus, and

wherein the second state is a non-operable state of the of the ink jet recording apparatus.

40. (new) A method of detecting a liquid consumed from a liquid container, which is mounted on an ink jet recording apparatus, comprising:

detecting an oscillation characteristic values of at least a first piezoelectric device coupled to the liquid container and a second piezoelectric device coupled to the liquid container;

determining an amount of liquid consumed from the liquid container based on a first oscillation characteristic value of the first piezoelectric device and a second oscillation characteristic value of the second piezoelectric device.

41. (new) An ink jet recording apparatus on which a liquid container is able to be detachably mounted, comprising:

a recording head receiving liquid from the liquid container and discharging a droplet of the liquid from a nozzle opening; and

a controller that detects a first oscillation characteristic value of a first piezoelectric device coupled to the liquid container and a second oscillation characteristic value of a second piezoelectric device coupled to the liquid container and that determines an amount of liquid consumed from the liquid container based on the first oscillation characteristic value and the second oscillation characteristic value.

42. (new) An apparatus for controlling an ink jet recording apparatus on which a liquid container is able to be detachably mounted, comprising:

a detection circuit that detects a characteristic value of a piezoelectric device coupled to the liquid container;

a control circuit that determines whether or not the characteristic value satisfies a predetermined condition and that sets the ink jet recording apparatus in a first state or in a second state based on whether or not the characteristic value satisfies a predetermined condition,

wherein a vibrating region of the piezoelectric device extends from a liquid level of the liquid before the liquid is consumed to a bottom surface of the liquid container.

43. (new) An ink cartridge configured to be detachably mounted on an ink jet recording apparatus comprising:

a container containing an ink;

a piezoelectric device that is positioned slightly below an initial ink level which corresponds to a level of said ink in the container before ink is initially consumed from the container.

44. (new) The liquid container according to claim 10, wherein said piezoelectric device has a vibrating portion which comes into contact with said liquid via a cavity in said container body, said vibrating portion covering an area of an outer opening of said cavity.